Southwest Fisheries Science Center
Administrative Report H-91-09

SUMMARY OF SWORDFISH LONGLINE OBSERVATIONS IN HAWAII, JULY 1990-MARCH 1991

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INTRODUCTION

The longline fishery specifically targeting swordfish, *Xiphias gladius*, was begun experimentally by the fishing vessel *Magic Dragon* in 1988. Prior to 1988, swordfish had been a small, incidental catch of the traditional tuna longline fishery, as well as the *ika shibi* (handline) fishery. By the end of 1989, the number of vessels targeting swordfish for at least part of the year had increased to 10, about 10% of Hawaii's longline fleet. Swordfish landings in 1989 totaled an estimated 650,000 lb, compared with landings of 50,000 lb in 1988. About 50 longline vessels were active in the swordfish fishery in 1990, and landings exceeded 3.5 million lb (valued at approximately $6.2 million). The vast majority of the swordfish are landed fresh, headed and gutted in Honolulu, and then airfreighted to the U.S. mainland. Market reports indicate that swordfish from Hawaii have made a major entrance into the east coast wholesale markets. Total U.S. landings of swordfish in recent years have averaged 11 million lb, but future landings have been placed in doubt by recent regulatory changes on the east and west coasts. One effect of these regulations has been the migration of a substantial number (as many as 20) of east coast swordfish vessels to Hawaii.

The newly exploited swordfish are a part of an estimated Pacific-wide catch which has varied between 10,000 and 25,000 metric tons (t) (20-50 million lb). Most of this catch is from temperate water fisheries (e.g., the Japanese longline fishery in the Northwest Pacific and north of Hawaii at latitude 25-40°N). The estimated sustainable catch of swordfish Pacific-wide is 40 million lb (Sakagawa 1989; Skillman 1989).

Scientific observers were placed aboard a total of 10 swordfish longline vessels by the Honolulu Laboratory of the Southwest Fisheries Science Center (SWFSC), National Marine Fisheries Service (NMFS), NOAA. Observer placements were initiated for two major reasons: (1) Unconfirmed reports of interactions between swordfish vessels and protected species, such as Hawaiian monk seals, sea turtles, and seabirds, and (2) the lack of scientific information available on swordfish-directed longlining. Six of the vessels were observed on a voluntary basis in July 1990-October 1990 (Dollar et al 1991). The other four vessels were observed on a mandatory basis, under emergency regulations passed by the Western Pacific Fishery Management Council, in January-March 1991. Seven of the vessels were mainland swordfish longliners recently arriving in Hawaii, and three were Hawaii-based longliners. One of these has fished tuna in the main Hawaiian Islands (MHI), and the other two had fished primarily tuna outside the MHI. Three bottomfish vessels also carried observers to the NWHI, but information from those trips will be included in another report. Cooperation on the part of the vessel owners and captains was excellent.

The longliners fished in three areas: the MHI, the Northwestern Hawaiian Islands (NWHI), and the mid-Pacific waters north of Hawaii. One vessel fished only in the MHI, four fished in the NWHI, and the remainder fished in the mid-Pacific. The primary objectives of the observer trips were to record any interactions between the longline gear and protected species and to collect detailed catch and effort information from the newly emerging swordfish fishery. Detailed biological data also were collected as called for in the sampling protocol (Appendix A). Information about individual vessel operations is kept confidential.

INTERACTIONS WITH PROTECTED SPECIES

No interactions with protected species were observed in the MHI, but some occurred in the NWHI and mid-Pacific. Marine mammal interactions are summarized in Table 1, and scientific names are listed in Table 2. In the NWHI, a humpback whale became entangled in the gear of a longline vessel during recovery of one set. The young whale, about 8-10 m long, was entangled in the main line and could not move. The line apparently crossed through its mouth between the lips and baleen and extended in a double line under the right pectoral fin to the tail. The line appeared to encircle the tail more than once just anterior to the flukes. Since the whale was not able to raise its flukes completely to the surface, it was difficult to get the exact details of its condition. The double line extending from the jaw was so tight that the whale's back was severely arched, and its tail could not flex. After many unsuccessful attempts to free the animal, a grappling hook was used to hook the main line and draw the whale close to the boat. During this procedure, the line either loosened or broke, and the whale submerged under the vessel and swam away with its back still arched. No further attempts could be made to free the animal. In other operations in the NWHI, three false killer whales were observed in the area of the fishing gear, but no interactions were observed. Two large leatherback turtles were hooked (both by the front flippers) and entangled in the fishing gear. Both were released alive after the leader was cut as close to the hook as possible while the turtles were still in the water (both turtles were too large to bring on board). In addition, eight porpoises (unidentified species) were sighted in the area of the gear during one NWHI set, but no interactions were observed. No other sightings were made while gear was in the water.

In the mid-Pacific, there was one sighting of a solitary killer whale. After this sighting, almost every fish from the set was found damaged with only heads remaining on the hooks. After the gear was retrieved, the vessel moved to a new location to avoid further interactions. No negative impact on the whale was observed. There was one interaction with a sea turtle: A dead olive ridley turtle was recovered after being hooked in the

mouth during another set in the mid-Pacific. It was brought on board, photographed, measured, and discarded. One turtle of unknown species also was sighted during the same set, but it was too far away to be photographed.

In both the mid-Pacific and NWHI waters, there were several incidents involving albatrosses. Typically, the birds followed the boat during deployment and retrieval of each set. An average of 12-15 black-footed albatross were seen each day. In the mid-Pacific, 11 black-footed albatross were hooked and killed during deployment of the fishing gear. Birds usually became hooked early in the setting process when it was still light enough for them to see the bait. During one trip, as a precautionary measure, a line with a float was towed behind the vessel to scare the birds away; this was effective. Observers emphasized the importance of setting gear after dark and sinking the bait and hooks rapidly in order to avoid hooking birds during deployment.

During NWHI trips, two black-footed albatross and three Laysan albatross were recovered dead, and six black-footed albatross were released alive. During one NWHI trip, Laysan albatross approached the boat as gear was being deployed and retrieved, but none was hooked. Gear on this vessel had been modified to sink the light sticks and bait before the birds could attack them. Fireworks also were used to the scare birds away.

FISHING VESSEL OPERATIONS

All vessels initially targeted swordfish. However, on three trips, catches of marketable-sized swordfish were low, so bigeye tuna were targeted instead. No modifications to the longline gear or fishing techniques were made during this switch in target species.

Nine vessels were steel-hulled, and one was fiberglass over wood. Vessel lengths ranged from 58 to 88 ft (average, 76 ft). All vessels deployed monofilament gear (3.0-4.0 mm main line) and Cyalume[1] or World Plastics frozen light sticks, or both. Trip lengths varied from 11 to 23 days. The 10 vessels were at sea for a total of 184 days; 93 were spent fishing.

Depending on the vessel, location, and particular ocean conditions prior to setting, gear consisted of a main line of 20-50 miles of monofilament with a distance of 250-450 m between floats. The number of hooks deployed varied (450-1,800 per set). A total of 67,368 hooks were set during 10 trips; Figure 1 shows fishing effort in the study area (within 50 nmi of any of the NWHI) represented only 17.5% of the total hooks set (N = 11,828).

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Light sticks of various colors were attached with rubber bands to branch or dropper lines about 6 ft above the hooks (branch lines were approximately 36 ft long and consisted of 2.1 mm monofilment). Bait consisted of large (300-400 g) whole squid, saury, or mackerel. At times, squid were experimentally dyed with red or green food coloring to attract more fish. Not all branch lines contained light sticks. Cost per boat to set gear each day ranged from $1,000 to $1,700.

The number of sets made by the 10 vessels ranged from 6 to 14. Sixty sets were made in the mid-Pacific, 10 in the MHI, and 20 in the NWHI. Gear deployment usually started late in the day just before sunset and was completed by midnight. Hauling commenced just after sunrise the following morning. Soak time lasted 8-16 hours, depending on which end of the gear was hauled first.

On 8 of the 10 trips, a time-depth recorder (TDR) was deployed to collect data on the depth of the fishing gear: 5 recorded data successfully, 3 failed because of electronic malfunction. The TDR was usually attached with a 10-fathom ball drop to the main line midway between the two floats. The TDR information was submitted to the Pelagic Ecosystem Program of the Honolulu Laboratory, and a profile was given to each vessel owner or captain. On the remaining two trips, no TDR was available.

Plastic debris, including expended light sticks and monofilament gear discarded from each set, was collected and saved for on-land disposal on 6 of 10 trips.

CATCHES

Catches were divided into four categories: pelagic management unit species (PMUS), shark (also PMUS), tunas, and incidentally caught fish. Figure 2 shows species composition of the catch in number. Catch was also summarized by the total and average number of fish caught and by catch per unit effort (CPUE; catch per 100 hooks; Table 3). A total of 901 swordfish were hooked during the 10 trips, representing 25.9% of the total number of fish caught (N = 3,520). The number of swordfish caught equaled 13-71% of the total catch by individual trips. The mean size of measured swordfish (N = 525) was 127.1 cm eye-orbit fork length.

Swordfish under 23 kg are commonly called "rats" by the fishing industry, 23-45 kg swordfish are called "pups," and those over 45 kg are known as "markers." During five trips, the majority of the swordfish caught were rats. The rats were usually released regardless of whether they were dead or alive. Most of the rats were dead; however, two live rats were tagged with a dart tag and released. Swordfish destined for sale were headed, finned, gilled, and gutted on board.

Swordfish less than 23 kg were weighed on a portable scale; however, those larger than 23 kg (maximum scale capacity) were not weighed because of restrictions in time and space and the lack of a larger capacity scale. On seven of the trips, in order to obtain accurate dressed-to-whole weight ratios for >23 kg swordfish, the discarded parts (i.e., head, fins, tail, and guts) were weighed, and the fish were tagged with red surveyor's tape and numbered. This facilitated later identification and recovery of the actual dressed weight during unloading. Dressed swordfish (N = 653) equaled 72% of the total swordfish catch, for a total weight of 30,120 kg. Weight loss during transit was unaccounted for and represented a bias in the data. The dressed weight of all fish was recorded during off-loading operations in Honolulu.

As time and conditions allowed, supplementary biological measurements and samples were taken: morphometrics (a set of 6 morphometric measurements was taken from 110 swordfish), stomach contents, otoliths, and whole specimens. These data are being analyzed by Honolulu Laboratory scientists and will be reported elsewhere.

On most trips, sharks (by number) constituted the largest individual component of the catch, representing 33.2% (range, 15-55%) of the total number of fish caught. Blue sharks (N = 754) were the major shark species. Most of the sharks (90%) were released rather than landed. Some dead sharks were finned, and the fins were dried to be sold commercially. Mako, thresher, and pelagic white-tip sharks were usually landed and marketed with the rest of the catch. These species (N =89) represented 2.5% of the total catch.

During 10 trips, 387 bigeye and 171 yellowfin tunas were caught. Mean sizes of measured bigeye (N = 310) and yellowfin tunas (N = 45) were 129.5 and 148.8 cm fork length, respectively. During three trips, bigeye tuna (22%) and mahimahi (26%) dominated the catch. Figure 3 shows size distributions and relative frequency (percent) for swordfish, bigeye tuna, mahimahi, and yellowfin tuna.

The remainder of the catch consisted of various PMUS, such as blue marlin, striped marlin, and miscellaneous pelagic species including stingrays, lancetfish, and oilfish.

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CITATIONS

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Table 1.--Number and type of trips and number of interactions occurring in and out of a study area in the Northwestern Hawaiian Islands. "Inside" indicates sets made in the study area (50-mile zone); "outside" indicates sets made out of study area.

					Interactions (observed or actual)						Actual interactions with birds	
					Monk seals		Turtles		Whales/Porpoise			
Month out	Type	Month in	Inside[a]	Outside[a]	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside
1990												
Jul	LL-V[b]	Jul	5	5	0	0	2	0	8	0	0	0
Jul	LL-V	Jul	0	10	0	0	0	0	0	0	0	0
Jul	LL-V	Aug	0	14	0	0	0	0	0	0	0	2
Sep	LL-V	Sep	(trip aborted due to death in family of crew member)									
Sep	LL-V	Oct	0	10	0	0	0	0	0	1	0	0
Sep	LL-V	Oct	0	10	0	0	0	0	0	0	0	0
Sep	LL-V	Oct	0	7	0	0	0	0	0	0	0	0
Oct	BF-V[c]	Oct	93	0	2	0	0	0	50	0	0	0
1991												
Jan	BF-V	--	(exempted)									
Jan	BF-V	Jan	(trip aborted in Kauai due to mechanical problems)									
Jan	LL-M[d]	Feb	3	5	0	0	0	1	3	0	0	9
Feb	LL-M	Feb	3	3	0	0	0	0	0	0	2	0
Feb	LL-M	Mar	9	0	0	0	0	0	1	0	6	0
Feb	LL-M	--	(cancelled 2/91)									
Feb	LL-M	--	(cancelled 2/91)									
Mar	LL-M	Mar	0	6	0	0	0	0	0	0	0	0
Mar	LL-M	--	(cancelled 3/91)									
Mar	LL-M	--	(cancelled 3/91)									
Mar	LL-M	--	(cancelled 3/91)									
Mar	BF-M	Apr	79	0	1	0	0	0	1	0	2	0
Apr	BF-M[e]	May	164	0	0	0	0	0	0	0	1	0

[a]Numbers for longline vessels indicate sets; numbers for bottomfish vessels indicate drifts and anchor stations.
[b]LL-V = Longline-voluntary.
[c]BF-V = Bottomfish-voluntary.
[d]LL-M = Longline-mandatory.
[e]BF-M = Bottomfish-mandatory.

Table 2.--List of common and scientific names of fishes and protected species.

Common name	Scientific name
Pelagic Management Unit Species	
Swordfish	*Xiphias gladius*
Blue marlin	*Makaira mazara*
Striped marlin	*Tetrapturus audax*
Shortbill spearfish	*T. angustirostris*
Sailfish	*Istiophorus platypterus*
Mahimahi	*Coryphaena hippurus*
Ono (wahoo)	*Acanthocybium solandri*
Blue shark	*Prionace glauca*
Thresher (big eye)	*Alopias superciliosus*
Mako (short fin)	*Isurus oxyrinchus*
White tip (pelagic)	*Carcharhinus longimanus*
Tiger shark	*Galeocerdo cuvieri*
Gray reef shark	*Carcharhinus menisorrah*
Miscellaneous sharks	*Carcharhinidae*
Tunas	
Bigeye tuna	*Thunnus obesus*
Yellowfin tuna	*T. albacares*
Albacore	*T. alalunga*
Kawakawa	*Euthynnus affinis*
Skipjack tuna	*Katsuwonus pelamis*
Miscellaneous	
Lancetfish	*Alepisaurus* spp.
Oil fish	*Lepidocybium flavobrunneum*
Barracuda	*Sphyraena barracuda*
Stingray (pelagic)	*Dasyatis violacea*
Protected Species	
Hawaiian monk seal	*Monachus schauinslandi*
Humpback whale	*Megaptera novaengliae*
Killer whale	*Orcinus orca*
False killer whale	*Pseudorca crassidens*
Green turtle	*Chelonia mydas*
Olive ridley turtle	*Lepiodchelys olivacea*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coricea*
Laysan albatross	*Diomadea immutabilis*
Black-footed albatross	*D. nigripes*

Table 3.--Total number of fish caught, average daily catch, and catch per unit effort (CPUE; number of fish per 100 hooks) during 10 trips by longliners in July 1990-March 1991.

Species	Number caught	Average caught/day	CPUE
Pelagic Management Unit Species			
Swordfish	901	9.6	1.3
Blue marlin	38	0.4	0.06
Striped marlin	115	1.2	0.17
Other billfish	10	0.1	0.012
Mahimahi	376	4.0	0.56
Ono (Wahoo)	15	0.16	0.02
Sharks			
Blue sharks	754	8.1	1.10
Mako sharks	22	0.2	0.03
Thresher sharks	34	0.36	0.05
White tip (pelagic)	33	0.35	0.05
Gray sharks	12	0.13	0.02
Miscellaneous sharks	107	1.2	0.16
Unidentified sharks	213	2.3	0.32
Tunas			
Bigeye tuna	387	4.1	0.57
Yellowfin tuna	171	1.8	0.25
Albacore	16	0.2	0.02
Other tunas	9	0.1	0.01
Miscellaneous Incidentally Caught Fish			
Miscellaneous fish	304	3.3	0.45

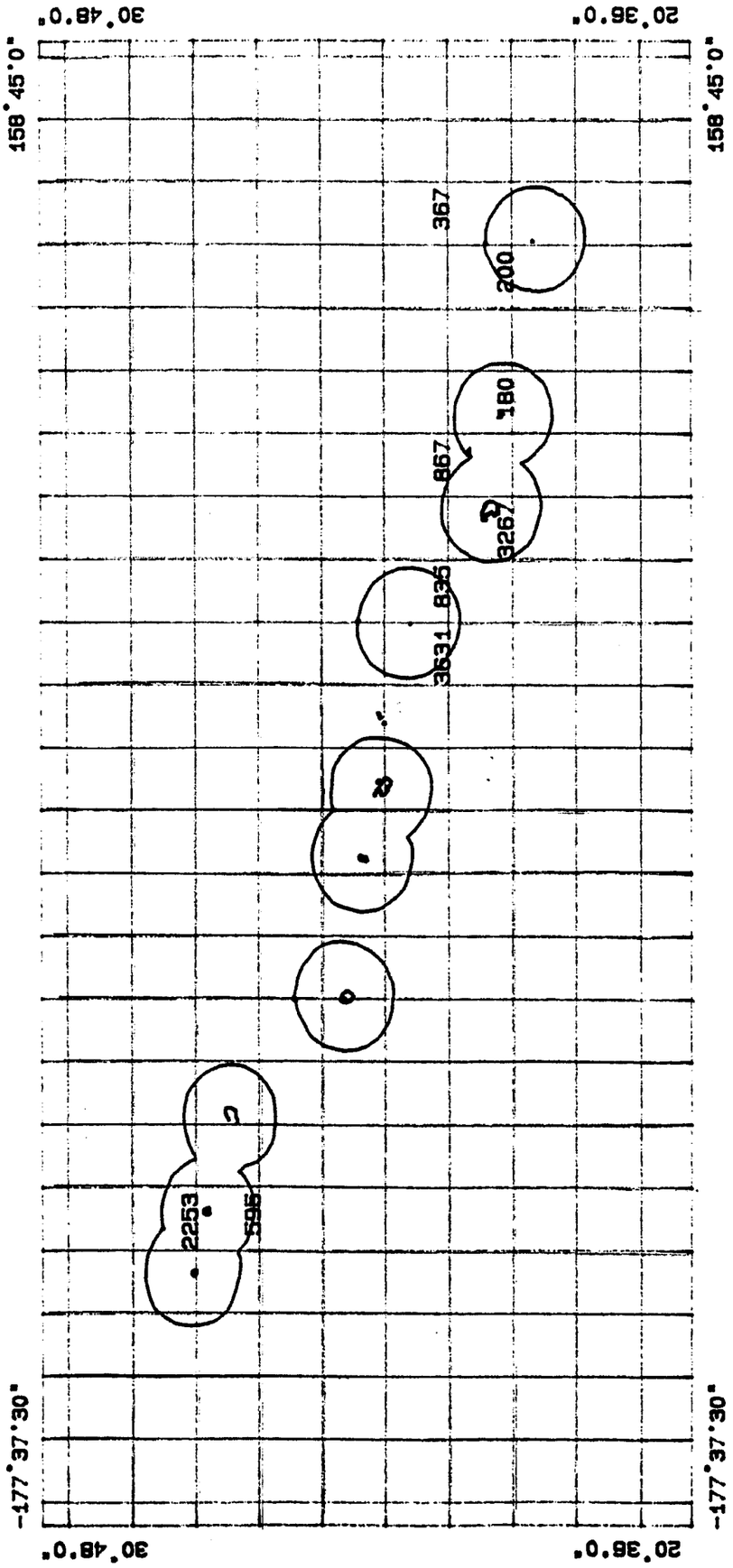

Figure 1.--Fishing effort within 50 nmi of Northwestern Hawaiian Islands (N = 11,828 hooks).

Longline Summary Report

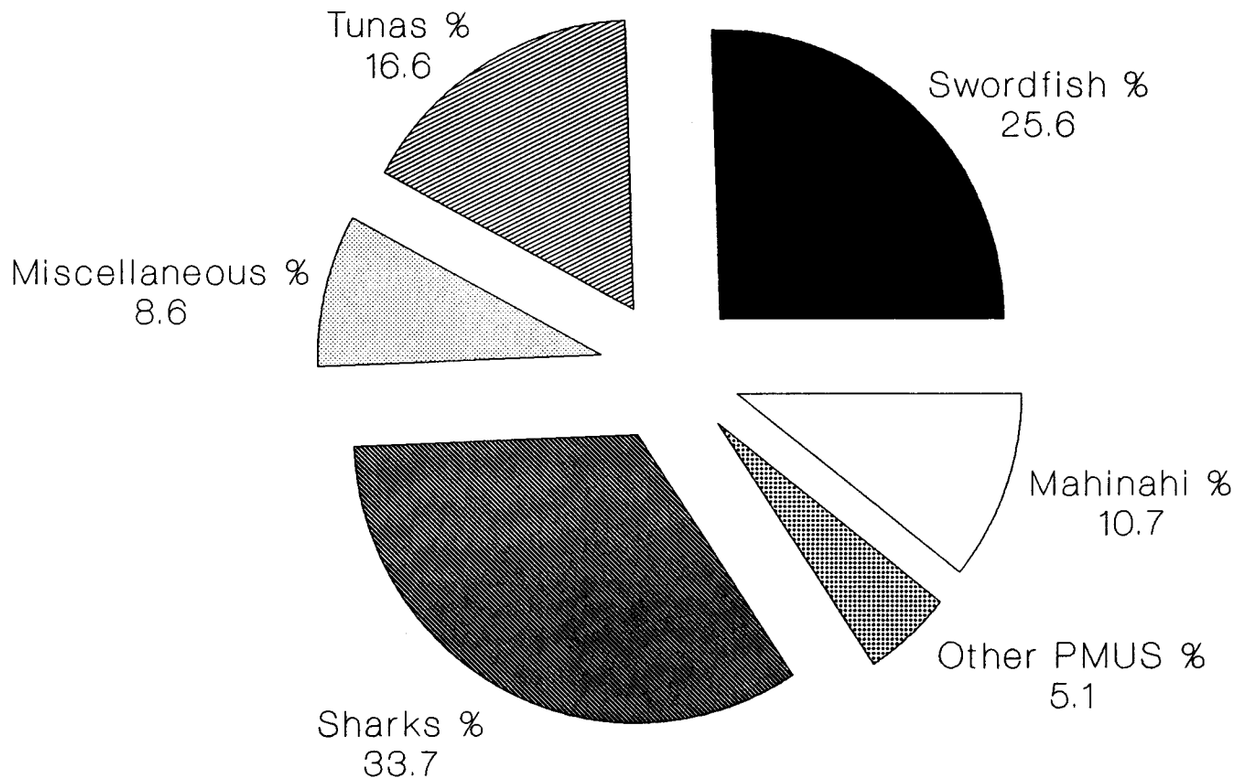

Figure 2.--Percent Species Composition

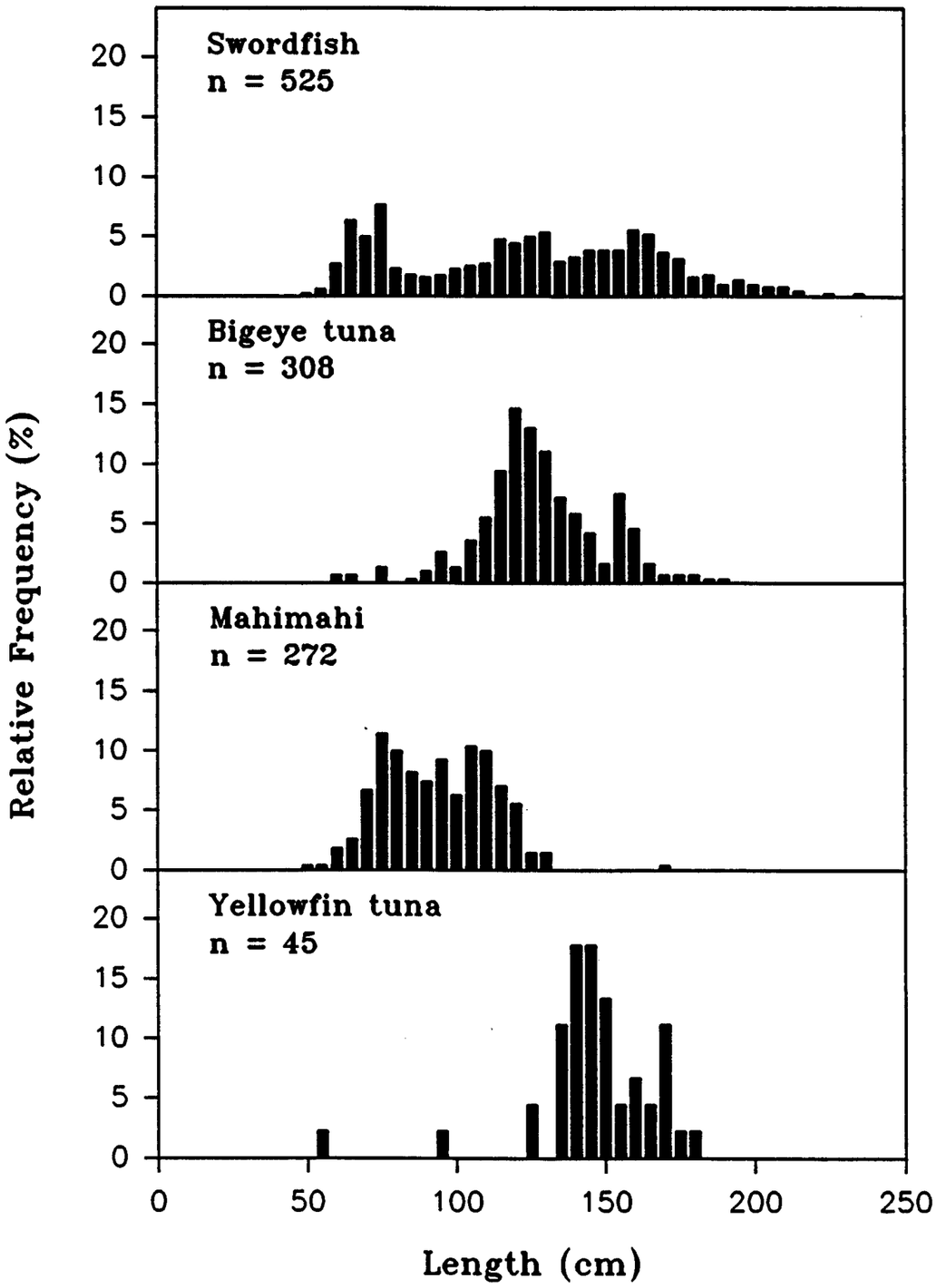

Figure 3.--Length-frequency histograms for swordfish, bigeye tuna, mahimahi, and yellowfin tuna.

Appendix A.--Swordfish observer protocol.

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July 5, 1990

Swordfish Observer Protocol

Fishery Management Research Program observers aboard longline fishing vessels targeting swordfish, especially in the Northwestern Hawaiian Islands, have the following priorities:

1. Fishing effort data
   a. Type of gear deployed
   b. Time-depth recording

2. Catch sampling log
   a. Location of set
   b. Catch (individual fish) (species, sex, length)
   c. Oceanographic conditions

3. Endangered and protected species interaction summary log
   a. Interactions observed during setting and hauling gear
   b. Photos of animals in water
   c. Photos and measurements of dead animals on deck (animals will be released upon measurement)

4. Supplementary biological measurements and samples
   a. Recovery rates
   b. Morphometrics
   c. Other biological samples (e.g., otoliths)

Supplemental observations include fishing gear and techniques and neighboring vessel activity.